RECLAMATION

Managing Water in the West

Collaborative Proposal No.: 93

CONCEPTUAL DESIGN FOR SAN ACACIA FISH PASSAGE STRUCTURE

Conceptual Design Report

U.S. Department of the Interior
Bureau of Reclamation

September 2004

MISSION STATEMENTS

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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CONCEPTUAL DESIGN FOR SAN ACACIA FISH PASSAGE STRUCTURE

Conceptual Design Report

by:

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U.S. Department of the Interior
Bureau of Reclamation
Albuquerque Area Office
Technical Service Division
Design and Construction Group
Albuquerque, New Mexico

September 2004

ACKNOWLEDGEMENTS

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Reclamation's Environmental Division - Albuquerque, NM

Reclamation's Facilities & Lands Division – Albuquerque, NM.

Reclamation's River Analysis Team – Albuquerque, NM.

LIST OF ABBREVIATIONS AND ACRONYMS

2003 BO	March 17, 2003 Biological Opinion
cfs	Cubic Feet per Second
dam	San Acacia Diversion Dam
LFCC	Low Flow Conveyance Channel
MRGCD	Middle Rio Grande Conservancy District
Reclamation	Bureau of Reclamation
silvery minnow	Rio Grande silvery minnow

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Introduction

Objectives

The Bureau of Reclamation's (Reclamation) objective for this report is to develop conceptual designs for a fish passage structure that allows the Rio Grande silvery minnow (silvery minnow) to pass upstream and downstream of the San Acacia Diversion Dam (dam). The conceptual designs contained in this report include the engineering methodology, conceptual drawings, and appraisal level construction cost estimates for the proposed silvery minnow fish passage structure.

The engineering designs which were developed will allow the silvery minnow to access available habitat upstream of dam. These conceptual designs do not provide measures to prevent entry of non-native and predator species into the proposed fish bypass channel. This fish bypass channel would allow for better silvery minnow distribution within the river system upstream of the diversion dam. The design and location of the fish passage addresses requirements stated in the March 2003 Biological Opinion (2003 BO).

The final design will need to address concerns from U.S. Fish and Wildlife Service, Middle Rio Grande Conservancy District (MRGCD), and other stakeholders with a vested interest in the area.

General Site Conditions

The dam is located on the Rio Grande approximately 16 miles north of Socorro, New Mexico.

The dam was built in 1934 by the MRGCD and rehabilitated in the 1950s by Reclamation. The dam is listed on the national historic register. The left dam abutment and river embankment contain significant archeological sites.

The dam presently provides diversions for the Socorro Main Canal operated by MRGCD and Low Flow Conveyance Channel (LFCC) operated by Reclamation. The diversion dam provides grade control within the Rio Grande at this location by preventing downstream degradation from extending upstream of the dam.

Statement of Need

The need for a fish passage or methods to allow the silvery minnow to move upstream of the dam is addressed in the 2003 BO.

Design

Barrier

The dam is a barrier to the upstream movement of silvery minnow because of degradation that has occurred downstream of the diversion dam over recent years. An alternative to allow the silvery minnow to travel upstream of the diversion dam is to construct an open trapezoidal channel that bypasses the dam. The Technical Services Division of the Albuquerque Area Office is providing conceptual designs for the bypass channel. The scope of this study includes providing the hydraulic characteristic of the bypass channel and the type of fish channel entrance and exit structure to be used.

Topography

The project area was surveyed, and a topographic map was created to show the existing concrete and earthen features to assist in the conceptual design process. Existing land boundaries were also located as noted in county records.

General

The project scope was broken into four areas that are addressed in this conceptual design report. The four areas include:

- Design of the Open Trapezoidal Channel (Fish Passage Structure),
- Design and Features of the Fish Entrance Structure (Downstream Outlet Flows),
- Design and Features of the Fish Exit Structure (Upstream Inlet Flows), and
- Design concerns related to possible modifications of dam, the existing Archeology sites that are located on the left river embankment, and site access for Construction and Operation and Maintenance activities.

Channel

Criteria incorporated into our report from the draft report entitled “Swimming Performance of Rio Grande Silvery minnow” which shall be referred to as “draft report” in this document. These criteria are described below:

- silvery minnow’s maximum swimming rate that was observed in the swim chamber is 118 cm/s (3.87 ft./s).
- The swimming fatigue performance curve for the silvery minnow was

reduced at water velocities greater than 50 to 60 cm/s (1.61 ft./s to 1.97 ft./s), although short bursts were possible for the silvery minnow.

- To maintain substantial upstream swimming performance for the silvery minnow, the channel velocities would need to be lower than 50 to 60 cm/s (1.61 ft./s to 1.97 ft./s).

- The maximum water velocities in shorter rock channels should not exceed about 100 cm/s (3.28 ft./s).

- The maximum water velocities in longer rock channels should not exceed about 75 cm/s (2.46 ft./s), provided there is substantially lower velocity boundary areas, i.e. boulder breaks, channel margins, resting ponds, within the channel system.

- The recommended channel gradient is less than 1.25 percent.

- The silvery minnow is attracted to flows that are somewhat faster then the body of water into which they are flowing. and

- Attraction flows should be tranquil and not turbulent.

The 2003 BO states that a minimum flow of 50 cfs should be bypassed through dam to maintain habitat downstream of the diversion dam for the silvery minnow. Anticipating leakage around the existing diversion dam, a design flow of 35 cfs was used for the normal bypass flow in the fish passage structure. Flows above 35 cfs were also analyzed in the fish passage structure.

A hydraulic profile of the bypass channel (trapezoidal) was developed, using HEC-RAS Version 3.1.2 and using the software feature "bridge piers" as the boulder breaks to analyze the flow velocities between the boulder breaks within the resting ponds. The flow velocities between the boulders were determined by using the flow momentum theory. Numerous iterations using various channel configurations were tried by varying the following hydraulic features: channel width, hydraulic gradient, spacing of boulder breaks, length of resting ponds, space between boulders, etc.

The final design calculations for the bypass channel were based on the following hydraulic parameters:

- a trapezoidal channel flowing 35 cfs,

- a channel gradient at 1.0 percent (slope = -0.01),

- a bottom channel width of 5 or 7 feet and 2:1 side slopes,

- a longitudinal distance between boulder breaks of 10 to 15 feet,

- a transverse spacing between boulders of 1 to 2 feet,
- a average water depth in the fish bypass channel between 3 and 4 feet,
- a maximum water surface head (H) of 17 feet (Checked Water Surface behind dam),
- a velocity (V_{bb}) of less than 2.00 ft./s between boulders, and
- a velocity (V_{rp}) of less than 1.50 ft./s between boulder breaks in the resting ponds. This would be accomplished by installing the maximum number of boulder breaks within the channel to sustain slower velocities less than 1.50 ft./s in the resting ponds.

The two alternative designs included in this report have the same hydraulic features for the open trapezoidal channel but are located in different areas along the left embankment of the river looking downstream.

The typical channel hydraulics and distances between boulder breaks are shown on drawing "Typical Channel Cross Section for 5 and 7-Foot Bottom Widths." The drawing shows a typical trapezoidal channel having an hydraulic gradient of 1 percent, a bottom width of either 5 or 7 feet, and 2:1 side slopes. The approximate channel length downstream of the diversion dam is 1,000 feet. The approximate channel length upstream of the diversion dam is 700 feet. The boulder breaks are formed by placing three boulders across the bottom of the channel and if required one boulder placed on each side slope. The middle boulder will be moved upstream or downstream to fine tune the drop in hydrostatic head between resting ponds. The distance between boulder breaks is approximately 10 to 12 feet. The typical boulder size will be 2.5 feet wide by 3.5 feet high. The model runs indicated that an average flow velocity of 1.50 ft./sec. will exist in the resting ponds and 2.50 ft./s between boulders.

Both alternatives require the trapezoidal channel to pass through the last radial gate bay on the left side of the diversion dam looking downstream. The difference between Alternative One and Alternative Two is the location of the fish bypass channel in relation to the left river embankment.

ALTERNATIVE ONE

The channel is constructed along the left river embankment as shown on drawing entitled "Alternative One, Plan and Profile."

The following table lists some of the advantages and disadvantages for this channel location.

ADVANTAGES	DISADVANTAGES
Minimum excavation, and limit impact on river embankment.	Decreases Rio Grande floodway capacity, increase need for borrow material, increase dewatering costs, increase sheetpile costs, requires removal of existing cottonwood trees and vegetation on left river embankment.

Alternative Two

The channel is constructed in the left river embankment as shown on drawing entitled "Alternative Two, Plan and Profile."

The following table lists some of the advantages and disadvantages for this channel location.

ADVANTAGES	DISADVANTAGES
Minimize Rio Grande floodway Capacity losses, decrease need for borrow material, dewatering and sheetpile costs will be lower.	Big impact on river embankment including Archeology sites, requires increase removal of existing cottonwood trees and vegetation within centerline alignment.

Recommendation

Of these two alternatives, we recommended Alternative Two fish bypass channel, because of lower construction costs and engineering design features. Neither of these two alternatives reflect EIS and environmental impacts from constructing the fish bypass channel.

Fish Entrance Structure

The draft report states the silvery minnow is attracted to flows that are somewhat faster than the body of water into which they are flowing. The report also states that the attraction flows should be tranquil and not turbulent.

The design for the entrance (Bernal Entrance) to the fish bypass channel uses this information by locating the entrance in the pool area downstream of the diversion dam. The Bernal Entrance a single row of sheet pile starting at the entranceway to the fish bypass channel that is driven on a 30 degree arching pathway to the right river embankment. The sheet pile row will have notches of various heights to allow for different flow conditions in the river. At the entrance to the fish bypass channel is a series of large boulders (4-foot by 5-foot) which would be placed between the sheetpile and the left river embankment to create a tranquil flow condition between the fish bypass channel entrance and the river. The sheet

pile would also direct the silvery minnow to the approximate location of the entrance for the fish bypass channel. The Bernal Entrance is shown on drawing, "Alternative Two Typical Cross Section and Bernal Entrance Plan and Profile."

Fish Exit Structure

The exit structure is located upstream of the dam approximately 400 to 700 feet. The fish exit is a cast-in-place concrete structure using gates and structure location to allow for changing water elevations. The diversion dam upstream pool elevations are dependant on the check water surface used by MRGCD during the irrigation season, LFCC diversions, and normal non-irrigation depths behind the diversion dam. These water surface depths can vary up to 7.0 feet.

Additional factors that could be added into the final design for the fish exit structure include but are not limited to: the ability to track fish movement, sample fish, and measure the number of silvery minnow using the fish bypass channel.

The conceptual designs for the cast-in-place concrete fish exit structure are shown on drawing entitled, "Alternative One Typical Section and Exit Structure Conceptual Plan Views." Two fish exit structures are required depending on what elevation the water level is behind the diversion dam. This drawing only reflects one conceptual idea for the fish exit structures. A second study should look at different types of concrete structures for bypassing dam and allowing the silvery minnow access to the upstream habitat.

Site Access

Both of the alternatives described in this report locate the fish bypass channel upstream and downstream of the diversion dam on the left river embankment. By locating the fish bypass channel here, there will be access issues, both during the construction phase of the project and during the operation and maintenance phase.

It should also be noted that on the right embankment of the river both upstream and downstream of the diversion dam are the following structures: Drain Unit 7, headworks for the LFCC, headworks and sluiceway for the Socorro Main, and Burlington Northern Railroad tracks. Constructing a fish bypass channel on the right river embankment would also be difficult.

Archeological

The dam is on the natural historic register. Because of this, modification to the diversion dam was minimized. However some modification will be required to assure that the area around the gate bays is structurally sound.

As mentioned previously, these two alternatives locate the fish bypass channel on

or near the left river embankment where major archeological sites are located. To get archeological clearance, construction may be delayed.

Miscellaneous

As a part of this fish bypass channel work automating the existing radial gates at dam should be considered. Three existing gates at the diversion dam are currently automated. The gates at dam could work in concert with the gates at the fish bypass exit structure should a flood event occur.

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Appraisal Level Construction Cost Estimates

Alternative One Estimate (Contract Costs)

DESCRIPTION	ESTIMATED COSTS
Mobilization/Demobilization (Lump Sump)	$ 273,000
Diversion and Care of the Rio Grande (Lump Sum)	$ 362,000
Removal of Water (Lump Sum)	$ 113,000
Furnish and Install Two Road Crossings (Lump Sump)	$ 99,000
Pressure Grouting Diversion Dam Concrete Sill (Lump Sum)	$ 90,000
Contractor to Provide Excavator with Thumb for Adjusting Head Drop by moving Center Rock upstream or downstream (Lump Sum)	$ 9,000
Excavation (Cubic Yards)	$ 238,000
Backfill (Cubic Yards)	$ 187,000
Compacted Backfill (Cubic Yards)	$ 22,000
Borrow Material (Cubic Yards)	$ 117,000
Embankment Material	$ 235,000
Furnish and Install Sheet Piling for Channel Embankment (Tons)	$ 2,327,000
Furnish and Install Sheet Piling for the Bernal Entrance (Tons)	$ 530,000
Furnish and Install Gabion Baskets with Riprap (Cubic Yards)	$ 25,000
Furnish and Install Reno Mattresses with Riprap (Cubic Yards)	$ 120,000
Furnish and Install Membrane Lining (Square Yards)	$ 88,000
Furnish and Install Bedding and Cover Material for Membrane Lining (Cubic Yards)	$ 52,000
Furnish and Install 6-Inch Nominal Riprap for Channel	$ 324,000
Furnish and Install Large Boulders (3 Ft. by 4 Ft.) (Each)	$ 87,000
Furnish and Install X-Large Boulders (4 Ft. by 5 Ft.) (Each)	$ 16,000
Reinforced Cast-In-Place Concrete Exit Structure (Cubic Yards)	$ 1,052,000
Gates, Equipment, and Miscellaneous Metal Work for Exit Structure (Lump Sum)	$ 405,000
Automation Equipment for San Acacia Diversion Dam (Lump Sum)	$ 217,000
Contractor's Overhead at (15%) =	$ 1,048,200
Contractor's Profit at (10%) =	$ 698,800
Sub-Total =	$ 8,735,000
Contingencies (25%)	$ 2,183,750
Unlisted Items at (10%) =	$ 873,500
Appraisal Level Construction Cost Estimate for Alternative One =	**$ 11,792,250**

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Alternative Two Estimate (Contract Costs)

DESCRIPTION	ESTIMATED COSTS
Mobilization/Demobilization (Lump Sump)	$ 273,000
Diversion and Care of the Rio Grande (Lump Sum)	$ 326,000
Removal of Water (Lump Sum)	$ 113,000
Furnish and Install Two Road Crossings (Lump Sump)	$ 99,000
Pressure Grouting Diversion Dam Concrete Sill (Lump Sum)	$ 90,000
Contractor to Provide Excavator with Thumb for Adjusting Head Drop by moving Center Rock upstream or downstream (Lump Sum)	$ 9,000
Excavation (Cubic Yards)	$ 607,000
Backfill (Cubic Yards)	$ 235,000
Compacted Backfill (Cubic Yards)	$ 22,000
Borrow Material (Cubic Yards)	$ 28,000
Embankment Material	$ 138,000
Furnish and Install Sheet Piling for Channel Embankment (Tons)	$ 959,000
Furnish and Install Sheet Piling for the Bernal Entrance (Tons)	$ 530,000
Furnish and Install Gabion Baskets with Riprap (Cubic Yards)	$ 25,000
Furnish and Install Reno Mattresses with Riprap (Cubic Yards)	$ 53,000
Furnish and Install Membrane Lining (Square Yards)	$ 88,000
Furnish and Install Bedding and Cover Material for Membrane Lining (Cubic Yards)	$ 52,000
Furnish and Install 6-Inch Nominal Riprap for Channel	$ 324,000
Furnish and Install Large Boulders (3 Ft. by 4 Ft.) (Each)	$ 87,000
Furnish and Install X-Large Boulders (4 Ft. by 5 Ft.) (Each)	$ 16,000
Reinforced Cast-In-Place Concrete Exit Structure (Cubic Yards)	$ 1,052,000
Gates, Equipment, and Miscellaneous Metal Work for Exit Structure (Lump Sum)	$ 404,000
Automation Equipment for San Acacia Diversion Dam (Lump Sum)	$ 217,000
Contractor's Overhead at (15%) =	$ 862,050
Contractor's Profit at (10%) =	$ 574,700
Sub-Total =	$ 7,183,750
Contingencies (25%)	$ 1,795,938
Unlisted Items at (10%) =	$ 718,375
Appraisal Level Construction Cost Estimate for Alternative Two =	**$ 9,698,063**

In summary, the Appraisal Level Construction Cost Estimates range from $9.7 million for Alternative Two to $11.8 million for Alternative One.

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Appraisal Level Non-Construction Cost Estimate

Cost Estimate (Non-Contract)

Industry standard for Non-Contract cost is 25 percent to 35 percent of the construction costs. For the San Acacia Fish Passage Structure, these costs would range from $2.4 to $4.2 million for Non-Construction Costs.

Items included in the contingencies and unlisted line items for the above estimates are: EIS costs, mitigation, reseeding, environmental compliance, permit process, design data costs, design costs, and other costs discovered during the final design process.

SITE ACCESS COST ESTIMATE (NON-CONTRACT)

Costs included in this report also do not include obtaining site access to the Fish Passage Structure. Possible methods for site access to the left river embankment are:

- Construct an access road through the Sevilleta National Wildlife refuge to the construction site,
- Construct a temporary bridge across the Rio Grande from the right river embankment, or
- Construct a permanent bridge across the Rio Grande from the right river embankment.

To obtain access to the site, appraisal level cost estimates would range from $0.4 to $4.75 million.

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List of Attachments

Drawings

The following drawings are attachments to this report. The drawings are labeled as follows:

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

MIDDLE RIO GRANDE PROJECT – NEW MEXICO
SAN ACACIA DIVERSION DAM

CONCEPTUAL DESIGN FOR SAN ACACIA FISH PASSAGE STRUCTURE

PAGE NUMBER	ATTACHMENT LETTER	TITLE
16	A	Alternative One – Plan and Profile
17	B	Alternative One Typical Cross Section and Exit Structure Conceptual Plan Views
18	C	Alternative Two – Plan and Profile
19	D	Alternative Two Typical Cross Section and Bernal Entrance Plan and Profile
20	E	Typical Channel Cross Sections for 5 and 7-Foot Bottom Widths

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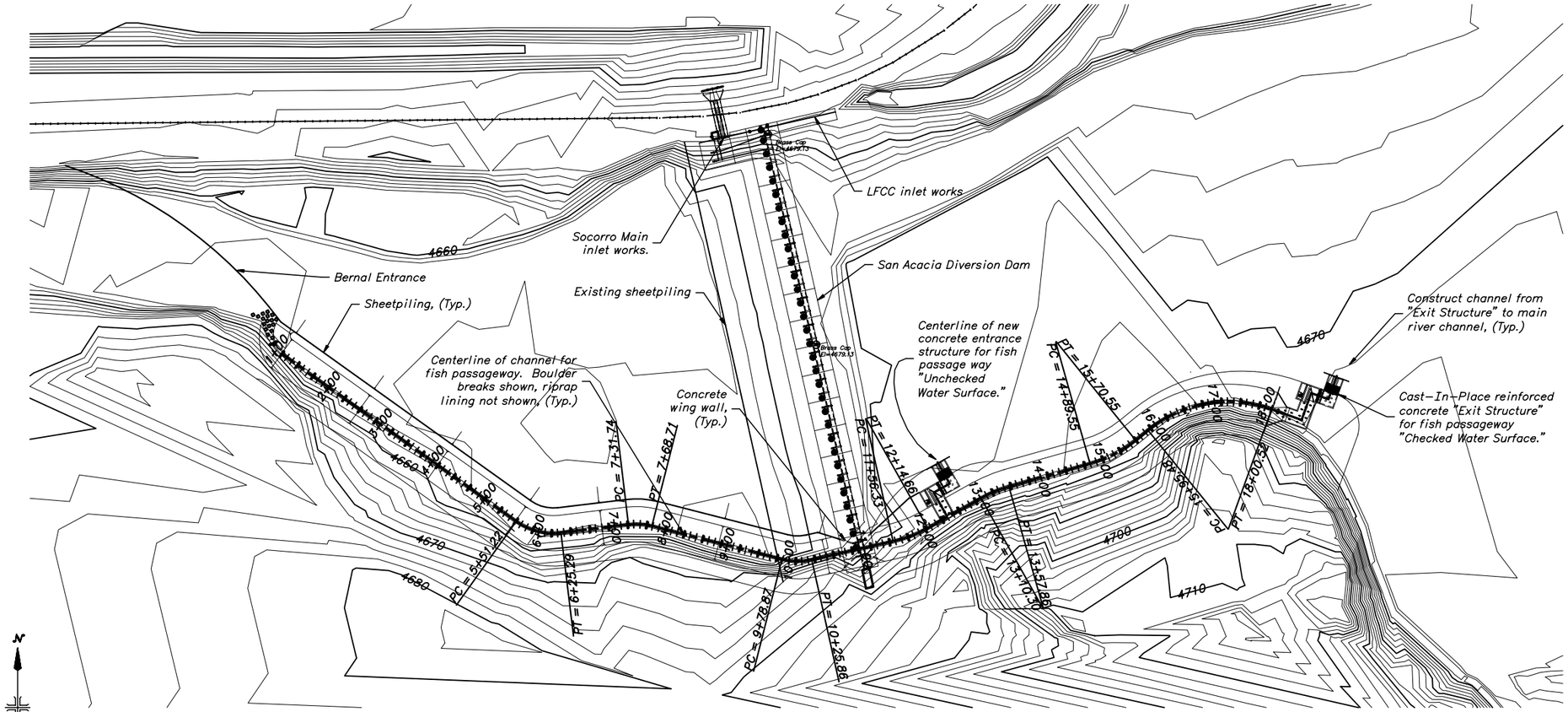
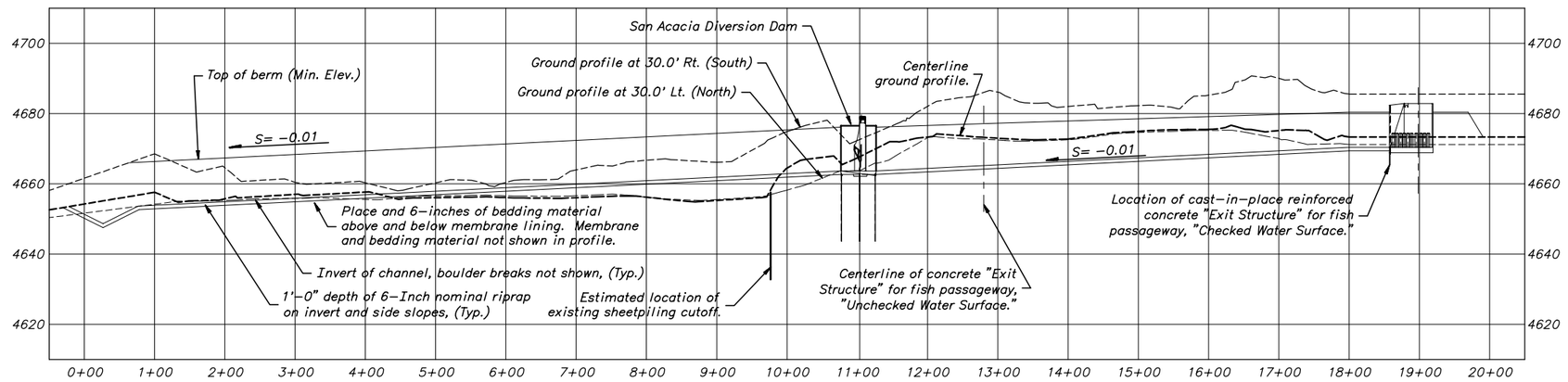
ATTACHMENT A



N

PLAN VIEW

100 0 100 200 300
SCALE OF FEET



PROFILE

NOTES

1. See attachment "B" for Typical Section and Fish Exit Structure Plan Views.
2. Riprap is not shown in either Plan or Profile. The boulders breaks are shown in Plan and not in the Profile.
3. The Fish Bypass channel shall pass through the last full size bay located on the left side looking downstream on San Acacia Diversion Dam.
4. The Fish Bypass channel minimum curve radius is 100.0 Ft.

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

MIDDLE RIO GRANDE PROJECT – NEW MEXICO
SAN ACACIA DIVERSION DAM

CONCEPTUAL DESIGN FOR SAN ACACIA FISH PASSAGE STRUCTURE
ALTERNATIVE ONE
PLAN AND PROFILE

DESIGNED R. Bernal CHECKED
DRAWN C.R. Everetts TECH. APPR.
APPROVED

CADD SYSTEM	CADD FILENAME	DATE AND TIME PLOTTED
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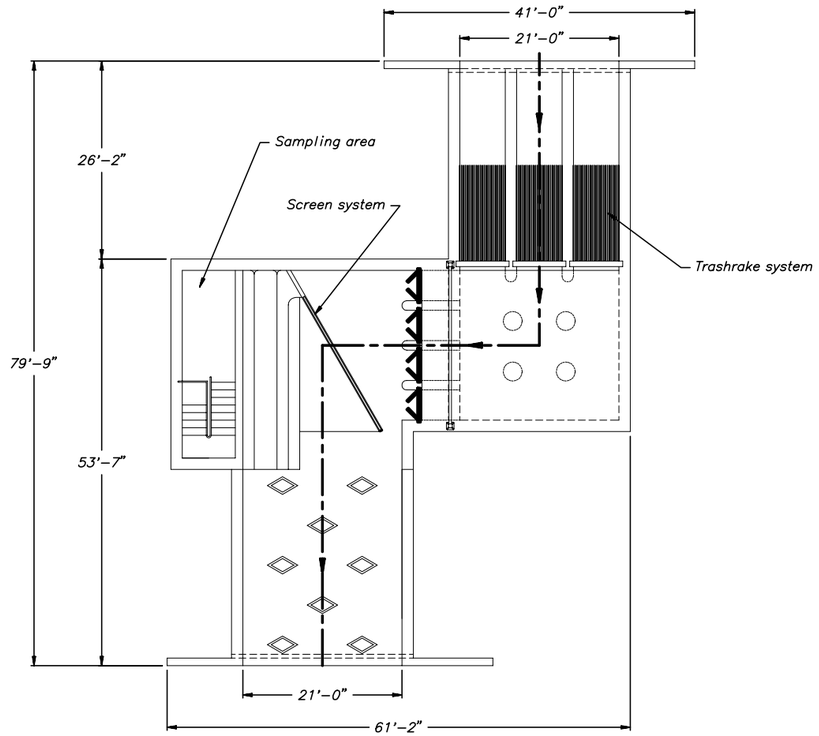
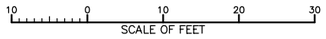
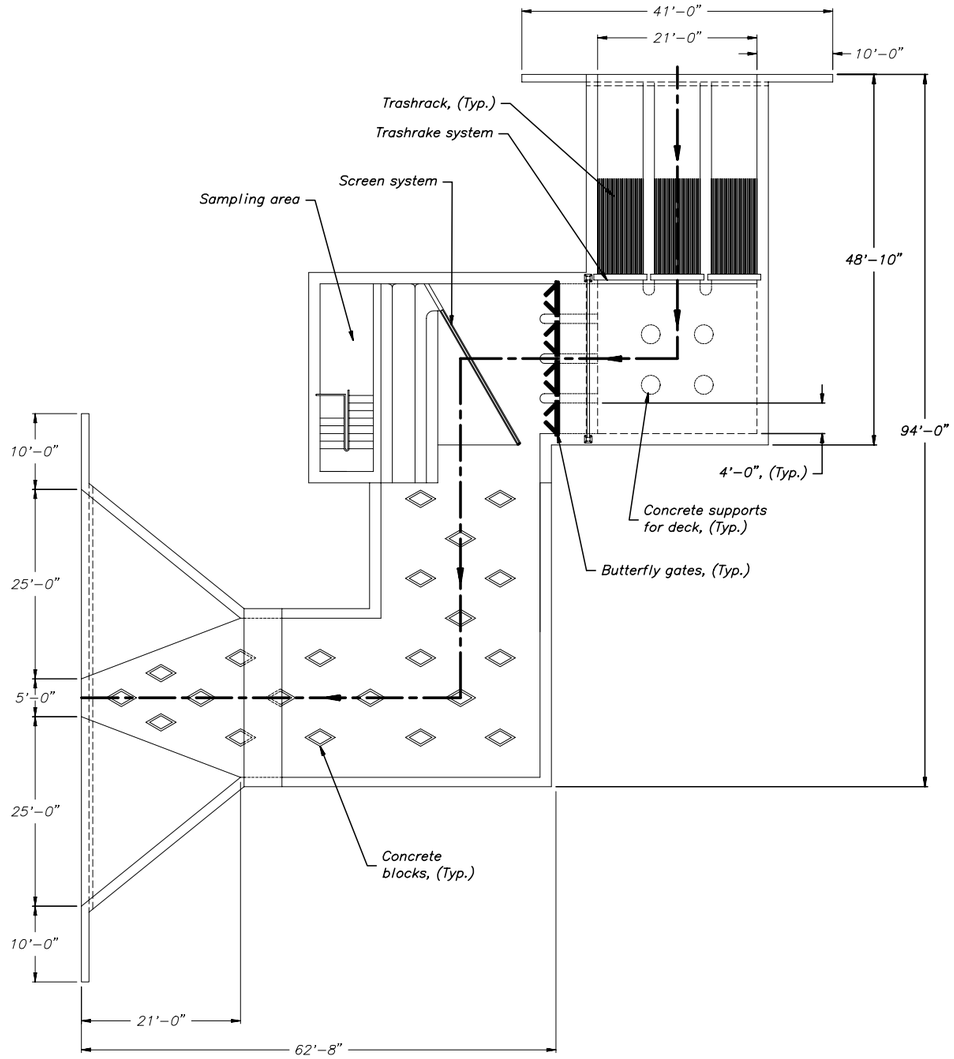
ALBUQUERQUE, NEW MEXICO AUGUST, 2003		ATTACHMENT A

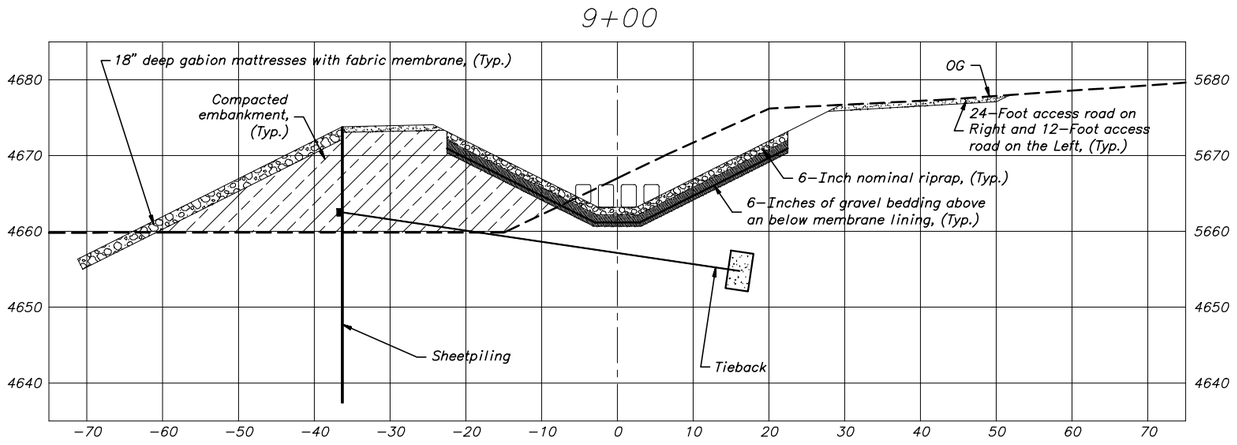


PLAN VIEW – CONCEPTUAL
(NON–CHECKED WATER SURFACE)





PLAN VIEW – CONCEPTUAL
(CHECKED WATER SURFACE)



TYPICAL CROSS SECTION
(CHANNEL PLACED ON SIDE OF RIVER EMBANKMENT)

NOTES

1. See attachment "A" for Alternative One Plan and Profile.
2. Plan Views for Fish Exit Structures are conceptual and will required additional designing and studying to assist to improve fish movement.

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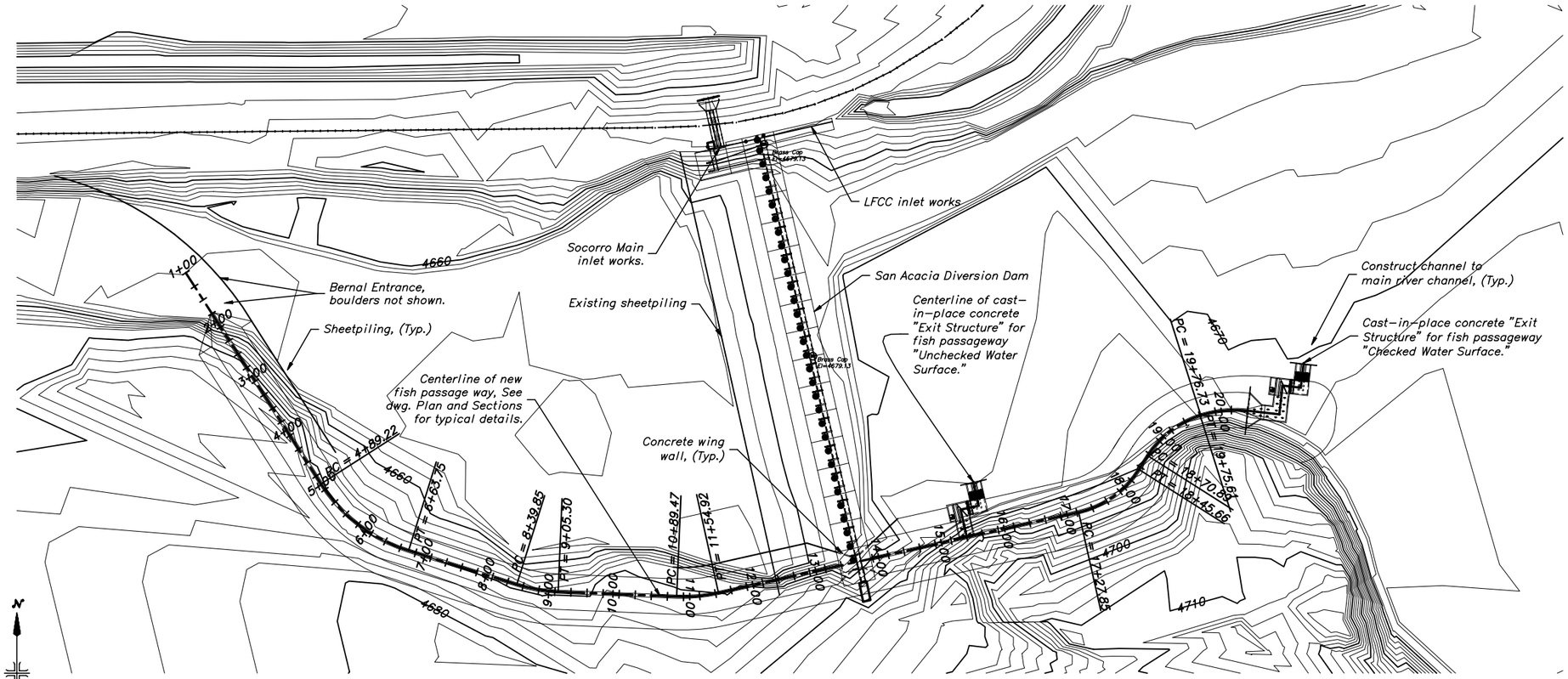
MIDDLE RIO GRANDE PROJECT – NEW MEXICO
SAN ACACIA DIVERSION DAM

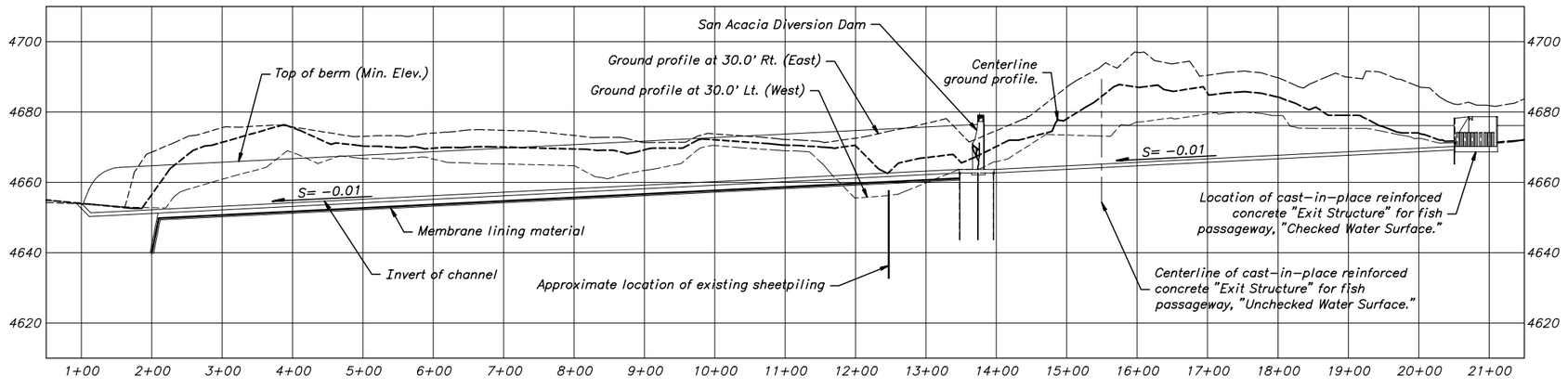
CONCEPTUAL DESIGN FOR SAN ACACIA FISH PASSAGE STRUCTURE

ALTERNATIVE ONE TYPICAL CROSS SECTION AND FISH EXIT STRUCTURE CONCEPTUAL PLAN VIEWS

DESIGNED C.R. Everetts	CHECKED
DRAWN C.R. Everetts	TECH. APPR.
APPROVED	
CADD SYSTEM AutoCAD Rel. 14.01	CADD FILENAME BP_PLN3.DWG
DATE AND TIME PLOTTED JANUARY 28, 2005 0900 HRS	
ALBUQUERQUE, NEW MEXICO AUGUST, 2003	ATTACHMENT B



PLAN VIEW



NOTES

1. See attachment "A" for Alternative One Plan and Profile and attachment "E" for Alternative Two Typical Cross Section.
2. The fish bypass channel will pass through the last full size bay on San Acacia Diversion Dam on the left side looking downstream.
3. Fish bypass channel curves shall have a minimum radius of 100.0 Ft.

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

MIDDLE RIO GRANDE PROJECT – NEW MEXICO
SAN ACACIA DIVERSION DAM

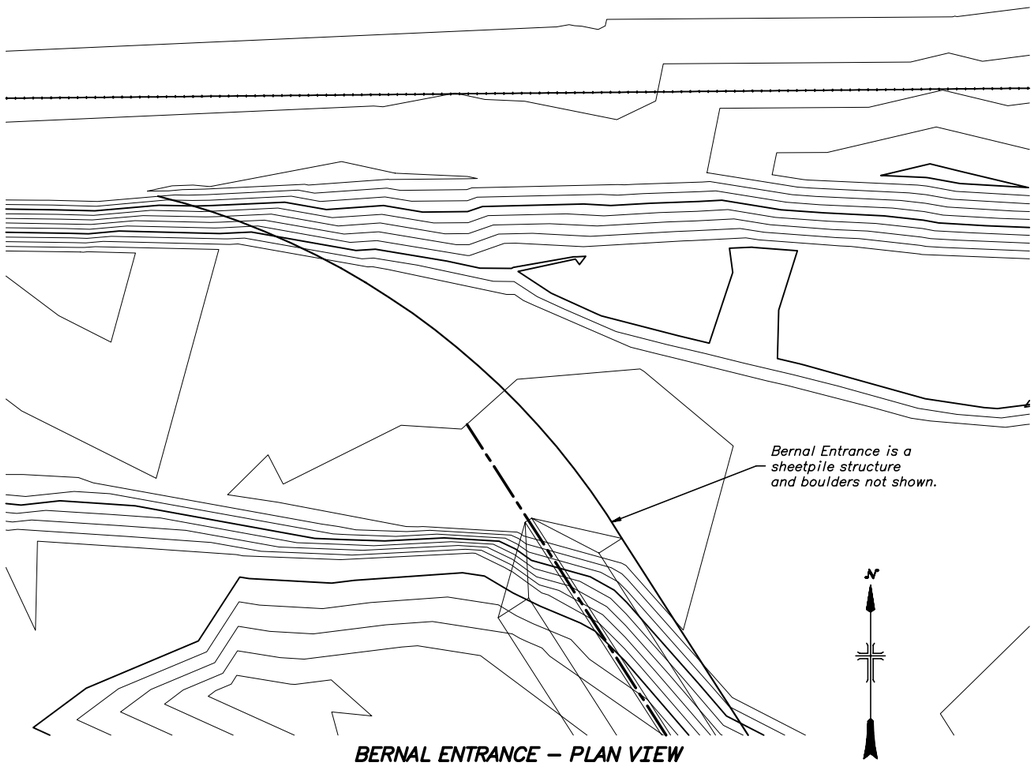
CONCEPTUAL DESIGN FOR SAN ACACIA FISH PASSAGE STRUCTURE

ALTERNATIVE TWO
PLAN AND PROFILE

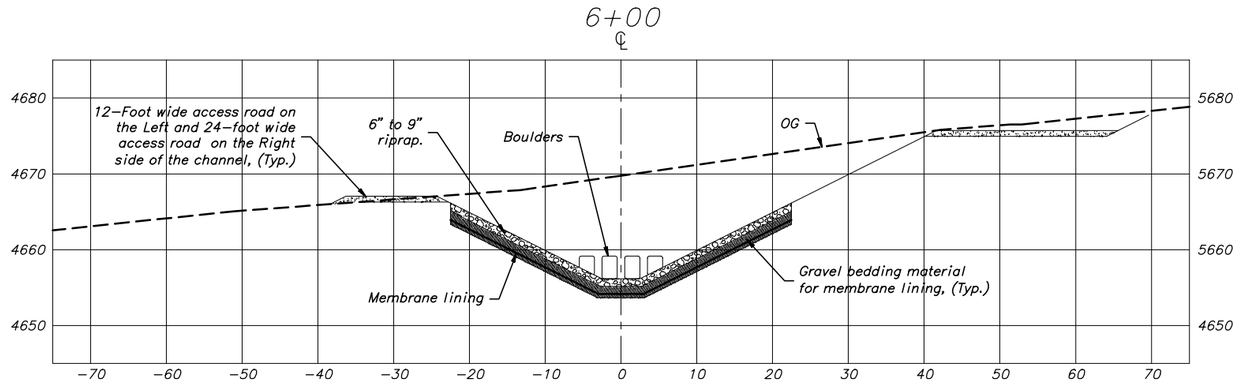
DESIGNED R. Bernal CHECKED
DRAWN C.R. Everetts TECH. APPR.
APPROVED

CADD SYSTEM	CADD FILENAME	DATE AND TIME PLOTTED
AutoCAD, Rel. 14.01 ALBUQUERQUE, NEW MEXICO	SABP_02.DWG AUGUST, 2003	JANUARY 24, 2005 1600 HRS.

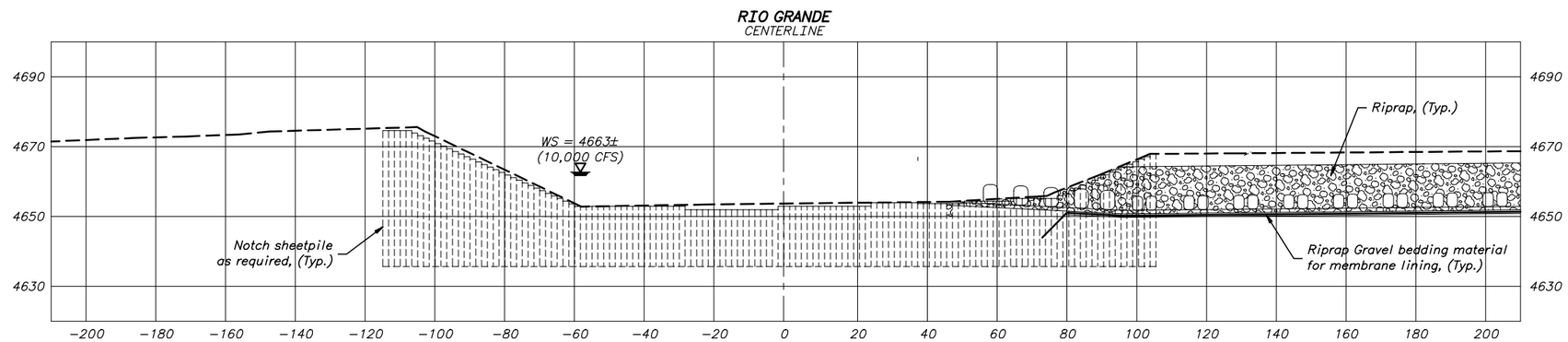
ATTACHMENT C



BERNAL ENTRANCE – PLAN VIEW



TYPICAL CROSS SECTION
(CHANNEL PLACEMENT ON RIVER EMBANKMENT)



BERNAL ENTRANCE – TYPICAL PROFILE
(LOOKING UPSTREAM)

NOTES

1. See attachment "C" for Alternative Two Plan and Profile and attachment "A" for Alternative One Plan and Profile.
2. The "Bernal Entrance" is constructed using sheetpile driven to varied cap heights to allow for varying flow conditions.

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BUREAU OF RECLAMATION

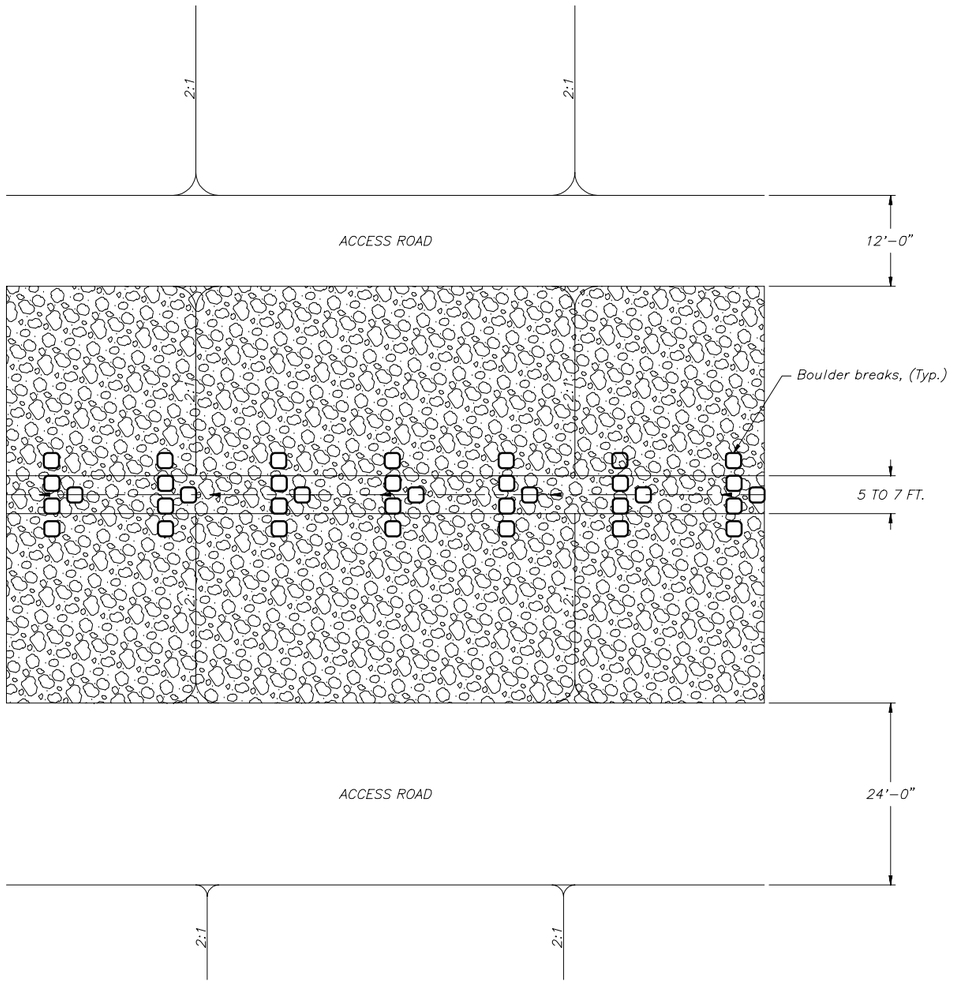
MIDDLE RIO GRANDE PROJECT – NEW MEXICO
SAN ACACIA DIVERSION DAM

CONCEPTUAL DESIGN FOR SAN ACACIA FISH PASSAGE STRUCTURE
ALTERNATIVE TWO TYPICAL CROSS SECTION AND BERNAL ENTRANCE PLAN AND PROFILE

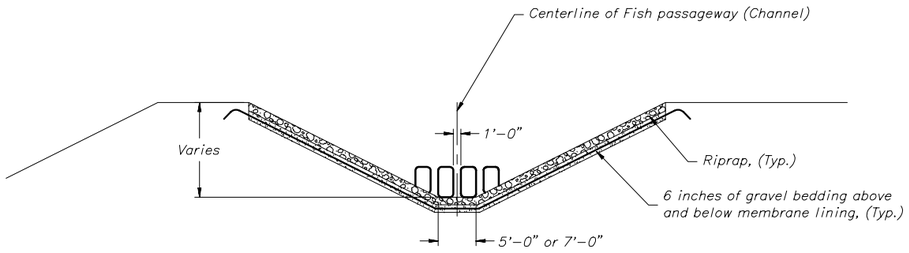
DESIGNED R. Bernal CHECKED
DRAWN C.R. Everetts TECH. APPR.
APPROVED

CADD SYSTEM	CADD FILENAME	DATE AND TIME PLOTTED
AutoCAD, Rel. 14.01 ALBUQUERQUE, NEW MEXICO	SABP_02.DWG AUGUST, 2003	JANUARY 24, 2005 1600 HRS

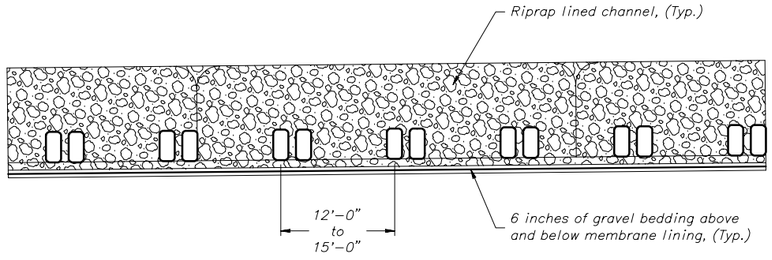
ATTACHMENT D



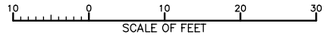
PLAN VIEW



TYPICAL CROSS SECTION
(LOOKING UPSTREAM)



PROFILE



NOTES

1. See attachment "A" for Alternative One Plan and Profile and attachment "B" for Alternative Two Plan and Profile.
2. The fish bypass channel will pass through the last full size bay on San Acacia Diversion Dam on the left side looking downstream.
3. Fish bypass channel curves shall have a minimum radius of 100.0 Ft.
4. Boulders size range from 2–foot by 4–foot to 3–foot by f–foot for use in the fish bypass channel and entrance structure.
5. Riprap is 6–inch nonmetal size.

GENERAL HYDRAULIC PROPERTIES
FISH BYPASS CHANNEL

$Q = 35$ cfs
$n = 0.030$
$S = -0.010$
$Z = 2.0$
$b = 5.0$ to 7.0 Feet

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

MIDDLE RIO GRANDE PROJECT – NEW MEXICO
SAN ACACIA DIVERSION DAM

CONCEPTUAL DESIGN FOR SAN ACACIA FISH PASSAGE STRUCTURE
TYPICAL CHANNEL CROSS SECTION FOR 5 AND 7–FOOT BOTTOM WIDTHS

DESIGNED R. Bernal CHECKED
DRAWN C.R. Everetts TECH. APPR.
APPROVED

CADD SYSTEM	CADD FILENAME	DATE AND TIME PLOTTED
AutoCAD, Release 14.01 ALBUQUERQUE, NEW MEXICO	SABP_03.DWG AUGUST, 2004	JANUARY 28, 2005 0900 HRS

ATTACHMENT E

References and Sources

Draft Report "Swimming Performance of Rio Grande Silvery minnow"
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